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Computing workshop
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Belgium National Day
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Theory Workshop
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INTERVIEW

"Astroparticle physics is perhaps a new way for particle physics to occupy space..."

Working at the University of Geneva, Bernard Revaz is in charge of studying the emergence of astroparticle physics. He tells us about his first ideas about the history of this young field.



Credits: © CERN

When was astroparticle physics born?

Ask astroparticle physicists and you'll hear very contradictory answers: some claim that there is a continuity from the 1940s up to now, while others trace the origin of the field to the 1980s with the solar neutrino problem... For me, a very important aspect is the appearance of

cosmology training classes in particle physics courses in the 1970s in the USA. It seems to have followed recommendations by the Academy of Sciences, which wanted the possibility to employ physicists in different fields. This is very important be-

cause it gave new particle physicists a strong background in cosmology, which obviously played a role in the link between particle physics and astrophysics. Today, there are physicists who do not consider the difference between working in cosmology or particle physics!

So astroparticle physics first comes from particle physics?

Yes, I think actually that a very big change occurred in particle physics, which is now looking for redeployment because of some kind of external pressure. Before, particle physics had a privileged access to the large funds necessary to construct and run large experiments, what we call 'Big Science'. It did not



have to negotiate in order to develop new instruments. But since the 1970s, things have changed. The hierarchy between the sciences has been largely blurred, so that particle physics has to compete with other fields of science. Think about space science, oceanography, genetics... There is no more hierarchical organization. In some ways, the ASPERA process is perhaps characteristic of this change as it is now trying to define priorities and to organize the astroparticle physics field. And perhaps we can see the emergence of astroparticle physics as a new way for particle physics to occupy space. Thus, astroparticle physicists go out from their laboratory to put their detectors outside, in nature, in space... By doing so they have to face new problems that you do not encounter in the lab, problems that are characteristic of a 'field science'.

What does it mean for such a young field to look back already on its history?

If astroparticle physicists decided to think about their own history, it is probably because they are looking for their identity. It follows the ASPERA process, which aims to give structure to the community, to institutionalize the field. Turning to history is perhaps important for astroparticle physics because in my opinion, it is also characteristic of another big change in science today: it becomes more and more interdisciplinary. When they place a detector undersea, for instance, astroparticle physicists have to work together with other fields such as oceanography. I think they work in a much more entangled manner than physicists do with civil or electronic engineers working on the LHC. So it is perhaps more difficult for such a field to be visible by itself, even if allying with other fields helps it to become stronger. It is interesting to note that astroparticle scientists may use results relevant for

other fields to attract attention on their experiment. Remember the recent story of the discovery of an important place for sperm whales in the Mediterranean Sea with the NEMO undersea neutrino experiment!

How will you work to study the emergence of astroparticle physics?

I have several avenues of research. One thing that is interesting for me is to know where astroparticle physicists come from. For instance, in which field did they do their PhD thesis? Where did they go after that? It is questions I'm doing a survey on. I also decided to work on a case study based on the archives of the AMS experiment, and I'm looking at how astroparticle physics emerged in literature. At last, I would like to gather evidence through interviews; all information is welcome.

What is the objective of the lectures you are organizing in Geneva called 'The reality of science today'?

Well, science goes faster and faster, but it is splitting up in more and more specialized areas and new subfields. This makes relationships between science and society increasingly complex. The aim of these lectures is to give another point of view on the scientific activity and to think about the scientific practice and its changes with scientists themselves. Dominique Pestre who is famous in the particle physics community for his work on the history of CERN will give the first lecture. I'm sure he will give us some really interesting material to think about regarding our work on the emergence of astroparticle physics.

Submitted by Arnaud Marsollier (CERN).



Next lecture by Dominique Pestre, 20 December 2007, 17h15 – University of Geneva: <http://www.unige.ch/sciences/Evenements/2007/RealiteScience.html>

ZEPLIN III is the latest of the ZEPLIN series detectors dedicated to the quest of the identification of dark matter. Despite its name it does not fly. On the contrary, it is installed underground at the Boulby mine in north-east England and is getting ready to probe, much deeper than its predecessors, for the existence of cold dark matter.



Credits: © ZEPLIN Collaboration

The direct detection of dark matter particles in the halo of the Milky Way would have profound implications for cosmology, particle physics and, possibly, to the whole of physics as we understand it today. Over the past decade a number of separate astronomical observations have been brought together to produce an impressively consistent model of the Universe. A new component of the Universe, known as 'cold dark matter', is required in quantities that outweigh normal matter by several times. Weakly interacting massive particles (50-1000 GeV) would meet the requirements for this component. Adding to this the existence of supersymmetry, which as a theoretical framework that is able to unify all the forces of nature, including gravity, predicts specific new 'sparticles' (i.e. supersymmetric particles) with just the right properties and we have a very well motivated scenario.



Running after dark matter. Credits: © ASPERA/Alexis Ferrier

The suggestion that sparticles are responsible for the cold dark matter in the Milky Way can be tested by several complementary approaches. In direct detection experiments, such as ZEPLIN III, the predicted interaction rate is about one per ton of detector material per day leaving individual recoil energy deposits up to ~ 50 keV. Indirect signatures would be via annihilation products such as anti-particles, neutrinos and gamma rays. Finally there is the prospect of actually producing new sparticles in the Large Hadron Collider at CERN, which could put supersymmetry and sparticle production in the early Universe on firmer footings.

The ZEPLIN III instrument is a two-phase xenon detector. The liquid phase of xenon provides a high density 'target' for the dark matter sparticles. Occasionally, one of these sparticles will scatter from a xenon nucleus in the liquid causing a brief flash of UV light, which is detected in an array of photomultipliers immersed in the xenon. At the same time ionization electrons are released which drift towards



Internal view of the photomultiplier (PMT) array within the ZEPLIN III detector. 31 2" PMTs are arranged in a hexagonal pattern. Above the PMTs there are two wire grids used as part of the electrode structure to define the electric fields. Credits: © H. Araujo

the surface of the liquid xenon with the help of an applied electric field. Indeed the field is strong enough that the electrons do not stop at the surface but get ripped out into the gas phase and cause light emission (electroluminescence). The light produced is then detected by the photomultiplier array. Hence the characteristic signal for the detection

of a sparticle is two flashes of light with a time delay between them, which depends on the depth within the liquid that the scattering took place.

ZEPLIN III is the latest and most advanced detector in the ZEPLIN series. Competitive results from its predecessor have just been published in *Astroparticle Physics Journal*. ZEPLIN III has a promised sensitivity that should give it an order of magnitude deeper to grasp the supersymmetric parameter space better than any other instrument currently operating underground.

The instrument is performing as expected and the final installation at the Boulby mine, which is located in north-east England is under way. A science-run will start in the new year. The first run will last for two months and should give a result comparable to current best sensitivities. Following this run the PMT array will be swapped for a specially commissioned low-background version, which will enable ZEPLIN III to go another order of magnitude deeper in sensitivity. At this level it will be probing some of the more favoured theoretical supersymmetry models and if nature is smiling upon us the first sparticles may show themselves in ZEPLIN III.



The full ZEPLIN III instrument in place in the Boulby underground laboratory within its inner layer of passive neutron shielding. Credits: © H. Araujo

Submitted by Tim Sumner (ZEPLIN III spokesman) and Georgios Fanourakis (DEMOKRITOS)

 ZEPLIN website : <http://astro.imperial.ac.uk/Research/ZEPLIN-III/>

MAGIC's twin will soon see the light

A second MAGIC telescope is under construction on the Canary Island of La Palma. From early 2008, the two MAGIC telescopes together will constitute a stereo system with excellent sensitivity and resolution for tracking gamma-ray sources of the Universe.

Ground-based gamma-ray astronomy has become a domain with spectacular discoveries: the issue at stake is the understanding of cosmic rays and, ultimately, the evolution of the Universe. These very-high-energy gamma-ray observations use Imaging Atmospheric Cherenkov Telescopes (IACTs), and cover roughly the energy domain from 50 GeV up.

The images permit scientists to reconstruct the gamma rays, after filtering out the cosmic ray background.

MAGIC is installed on top of a former volcano on La Palma, one of the Canary Islands and covers most of the Northern hemisphere. Presently, a single telescope with the world's largest mirror (17 m diameter), it has an edge over other IACTs in energy threshold, which can go as low as 50 GeV.

MAGIC started observing in 2003/2004. The target are sources observed before at different wavelengths (gamma-rays, X-rays, radio or optical), with a chance to emit, at least at times, very-high-energy (VHE) gamma-rays. So far, eight galactic and 11 extra-galactic sources have already been observed. Among the latest ones, we can mention supernova remnants, such as the famous Cassiopeia A, or the oldest VHE gamma-ray photons ever observed from very distant blazars, which are extremely active galaxies. X-ray binaries like Cygnus X-1 also provided the first experimental evidence of VHE emission from a stellar-mass black hole.

These kinds of observations are of great interest to understand better the mechanisms involved in these most violent processes of the Universe.

A second telescope with a structure similar to the MAGIC telescope is under construction, to be installed 85 m from the first one. The two MAGIC telescopes together will constitute a stereo system with excellent sensitivity and resolution, or offer the possibility to observe different sources simultaneously. The installation is well advanced, mirrors and camera will be added in early 2008 to the telescope structure already in place. Some technical improvements, most notably in the camera's photodetectors, will give MAGIC-II a sensitivity even better than the existing system.

MAGIC is a worldwide collaboration with a strong European component involving physicists from Armenia, Bulgaria, Finland, Germany, Italy, Poland, Spain, Switzerland and the United States.

Submitted by Masahiro Teshima (MAGIC spokesman), Carlos Pobes (FECYT/MEC) and Arnaud Marsollier (CERN)



The first MAGIC telescope at sunset, will be joined in early 2008 by a second telescope, MAGIC II. It will increase sensitivity and resolution for tracking gamma-ray sources of the Universe. Credits: © INFN.

Gamma-rays are absorbed in the atmosphere, where they develop particle showers that emit short flashes of blue Cherenkov light reaching the Earth. IACTs collect that faint light in a large-diameter mirror, and record an image in a pixelized camera of photomultipliers.



For more recent results from MAGIC: <http://wwwmagic.mppmu.mpg.de/physics/recent/index.html>

On 6 November, ASPERA celebrated its Sixth National Day at the Spanish National Research Council (CSIC) headquarters, Madrid. The Spanish Scientific Funding System was presented to an audience of about 40 people from both funding agencies and the Spanish community.

The Spanish Funding System has been recently changed. Until this year, Astroparticle Physics (ApP) projects were funded through the National Programme for Particle Physics emerging from the Ministry for Education and Science (MEC).



Montserrat Torné Escasany, General Director of Research at the Ministry of Science and Education presented the new Spanish research programme. On the left, Antonio Ferrer is the ASPERA coordinator for Spain. Credits: © ASPERA

In the new scheme, which will come into effect in the following months, there is one single programme for basic research where all disciplines will have to compete. A separate programme will be dedicated for grants in its different modalities (PhD, post-docs, technical, etc).

ApP research in Spain is mainly performed at universities. Spain is involved in several topics, including dark matter and dark energy, gamma rays, cosmic rays, gravitational waves, neutrino physics. There are two singular infrastructures where ApP experiments are performed: the Roque de los Muchachos Observatory (ORM), with experiments like MAGIC, and the Canfranc Underground Laboratory (LSC) dedicated to underground science. Funds for the infrastructures come from both the regional and central governments.

There are also two main public research institutions: CSIC and CIEMAT (Research Centre for Energy, Environment and Technology).

 MEC website : <http://www.mec.es>

 FECYT website : <http://www.fecyt.es>

CSIC inherited the former Council for Extension of Studies and Scientific Research created in 1907 by Nobel laureate Santiago Ramón y Cajal. It is the biggest one with more than 10 000 employees and over 100 research institutes distributed throughout Spain. There is a specific area for physical sciences and technology with some institutes developing research related to ApP (cosmology, astrophysics, particle physics).

The National Day commenced with the welcoming speech by Juan Fuster, manager of the National Programme for Particle Physics, and a presentation on ASPERA by Antonio Ferrer, ASPERA's coordinator for Spain. Afterwards, Montserrat Torné, General Director of Research, presented the new research programme, which was a good opportunity for the community to know the changes to the old system and raised interesting discussions. José Doncel, Deputy Director of Technological Policy and Infrastructures, gave an overview of the specific strategy for infrastructures.


As an example of the ApP infrastructure, LSC was presented by its director, Sandro Bettini, who gave an interesting overview of its history, status and future plans. Finally, a review of outreach in Spain was given by Eulalia Pérez, General Director of the Spanish Foundation for Science and Technology (FECYT), co-organizer of the event and one of the funding agency members of ASPERA.

As in previous National Days, Stavros Katsanevas closed the event with a summary of the main conclusions learned during the day. The beautiful place and the paella gave a very nice Spanish touch to this 6th National Day!



About 40 people from the European funding agencies attended the Spanish ASPERA National Day on the 6 November 2007. Credits: © ASPERA.

Submitted by Carlos Pobes (MEC/FECYT)

 All presentations of the Spanish National Day are available at:
http://www.aspera-eu.org/index.php?option=com_content&task=view&id=154&Itemid=94